

WASHINGTON

# SCIENCE TRENDS

HIGHLIGHTS

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## \* STORING LIQUID HYDROGEN IN ORBIT

Studies by the National Aeronautics and Space Administration at Huntsville, Ala. indicate that much future work remains to be accomplished if liquid hydrogen supplies are to be "stored" in orbit for space refueling purposes.

Most knowledge gained to date deals primarily with on-board vehicle hydrogen conservation, and does not take into account the basic differences in heat flux in an orbital storage tank and a vehicle tank -- which is an integral part of a larger system.

Preliminary conclusions indicate that if liquid hydrogen is to be stored in a geocentric (300 nautical mile) orbit or beyond, the commonly accepted concept of a vented storage tank is both "uneconomical and unnecessary."

For very short storage periods, NASA investigators say, the principle of non-vented storage has economical and technological advantages.

For long-term storage periods, according to NASA, the liquid hydrogen has to be subcooled before launch.

Before firm decisions can be made, these further studies have been recommended:

- ✓ A study of ground support equipment for liquid hydrogen subcooling, including evaporation, He-bubbling or refrigeration methods.
- ✓ A study of non-vented vehicle propellant tanks, to eliminate the problems associated with hydrogen venting on the launch pad and during powered flight.
- ✓ Further work by structural designers, to familiarize themselves with the various design possibilities of orbital propellant storage tanks as compared with vehicle propellant tanks -- with emphasis on cryogenic design considerations.

NASA investigators caution that calculations to determine storage times should be based on the assumption of having stagnant fluid conditions in the orbiting tank to obtain conservative results. The calculations should also consider the "fundamental difference" in thermal environment of a vehicle tank which is an integrated structural element, and an orbital storage tank, which is an individual structure except for the duration of powered flight.

(For further details see NASA Technical Note D-559, "Orbital Storage of Liquid Hydrogen" available from National Aeronautics and Space Administration, ATTN: Code BID, Washington 25, D. C.)

SATURN PROGRAM: First test launching of a Saturn booster is now scheduled for sometime in October at Cape Canaveral, Fla. Officials at the National Aeronautics and Space Administration are said to be well-pleased with progress to date.

## NEW DEVELOPMENTS FOR THE ARMY

### \* PAT VEHICLE

Chance Vought Corp. is releasing technical details of its Plenum Air Track vehicle being built for tests by the Army. Novel feature is a suspension system consisting of a plenum chamber filled with air at 1 psi pressure which is expected to provide a simple, lightweight and effective method of supporting the vehicle -- and protecting the vehicle when traveling at high speed over rough terrain. This suspension is combined with a rubber-impregnated track system.

The combination of ground effect and rubber track is expected to have exceptionally low ground pressure of about 1.0 psi -- giving high performance characteristics in water, mud, snow and bog as well as on highways and land surfaces.

Plenum Air Track Vehicle, in one configuration should travel at approximately 50 mph on the highway and 30 mph over water with an efficiency of 7 ton miles per gallon of fuel over rough terrain. The vehicle is 238" in length; 112" in width and 91" in height. Weights are: Empty -- 3,750 pounds; Normal Gross -- 7,900 pounds; Overload Gross -- 10,000 pounds.

### \* HUMMINGBIRD VTOL

Lockheed Aircraft Corp., Marietta, Ga. Division is disclosing additional technical details of its "Hummingbird" VTOL aircraft, two of which are being designed and built for the Army. The small, two-place, mid-wing monoplane employs two Pratt and Whitney JTL2A-3 turbo jets.

For vertical takeoff, the pilot opens doors over and under the fuselage-enclosed mixing chamber. He then activates a two-valve device which diverts high velocity exhaust from the engines into a chamber, and groundward via a bank of nozzles. According to Lockheed, this force induces an accompanying flow of surrounding free air, boosting the aircraft's vertical lift thrust by 40 percent with no additional fuel consumption.

For transition to forward flight, the aircraft is tilted slightly nose-down while accelerating. As wing lift increases, one engine is shifted to horizontal thrust. Acceleration continues, the second engine is shifted, the ejector doors close and conversion into conventional flight is completed.

For landing, the engine thrust is diverted at low power to vertical. Engine power is gradually increased as speed decreases.

Hummingbird, in its evaluation form is expected to have a maximum level cruise speed of 450 kt. Maximum vertical takeoff weight is 7,200 lbs. VTO range with a 300 pound payload is 290 nautical miles. A VTO ferry range of 520 nm is anticipated. Altitude capability is 40,000 feet. The aircraft would be useful for target acquisition and overall battlefield surveillance duty.

### \* BIRDIE

The Army is purchasing 18 transistorized versions of the Missile Master air defense coordination system developed by the Martin Co. The name is an acronym for Battery Integration and Radar Display Equipment. The system occupies 97 percent less space than Missile Master; uses 95 percent less power; requires 80 percent fewer personnel to operate and is air, sea and land transportable. Average cost per unit is \$500,000.

System is housed in shelters of sandwich-type aluminum stressed skin construction with styrofoam plastic boards between panels for rigidity and thermal insulation. Console employs a 19 inch diameter cathode ray display unit. Target data from external sources such as the SAGE system is transmitted digitally for decoding and processing and recording on a magnetic drum. Position and velocity information are routed to a computer, which continuously updates all track data. Stored information is automatically routed to a display generator, which converts the digital data on track symbols for display.

## TECHNICAL TRENDS

- Studies by the Atomic Energy Commission indicate that nuclear power supplies would make an ideal electrical source for the Surveyor "soft" lunar landing experiment. Research and development will be carried out with the objective of delivering flight units in time for an early 1964 launching. ✓✓✓ The Air Force Aeronautical Systems Command has contracted with Sperry Gyroscope Company to extend the performance of its magnetic digital computer, which, according to the manufacturer, can already operate reliably for up to 20,000 hours. ✓✓✓ Structural design criteria for aerospace vehicles will be studied by Republic Aviation Corp. under an Air Force contract which also calls for a comprehensive investigation of internal components such as piping, electrical harnesses and equipment supports. ✓✓✓ A statistical study showing that marketed production of natural gas in the U. S. rose 6 percent in 1960 is available as Mineral Market Report MMS 3298 from the Natural Gas Section, Branch of Petroleum Economics, Division of Petroleum, U. S. Bureau of Mines, Washington 25, D. C.
- The National Bureau of Standards hopes to have its new IBM 7090/1401 computing system in operation by mid-November, 1961. ✓✓✓ Federal Aviation Agency and the U. S. Army are cooperating in "Project Little Guy" aimed at developing a greatly simplified cockpit designed to meet the needs of light plane pilots. ✓✓✓ The U. S. Geological Survey is starting a continuing geochemical census to acquire data on the distribution of the elements in ordinary rock in hopes of improving knowledge of low-grade deposits and the distribution and origin of "new" elements. A survey of current mineral research requirements by Director T. B. Nolan is available from the Information Office, U. S. Department of the Interior, Washington 25, D. C. Ask for Release No. 99356-61. ✓✓✓ A list of 164 life science research contracts recently awarded is available as Announcement IN-248 from the Information Office, U. S. Atomic Energy Commission, Washington 25, D.C.
- The eight-engine Saturn launching vehicle generated from 25 to 40 megawatts of acoustic power during static tests at Huntsville, Alabama. A survey (TN d-611) is now available from National Aeronautics and Space Administration, CODE BID, Washington 25, D. C. ✓✓✓ A U. S. study of Soviet corrosion research in the past decade turned up no signs of any "major breakthrough", but points out that the Russians are abreast of the latest Western developments. A 143 Page report is now available at \$2.75 from OTS, U. S. Department of Commerce, Washington 25, D. C. Ask for Publication 61-31480. ✓✓✓ A survey of laboratory paint examination procedures is being published in the September Law Enforcement Bulletin of the FBI, U. S. Department of Justice, Washington 25, D. C. ✓✓✓ The U. S. Department of Commerce sees 1961 as "another peak year" for the communications equipment manufacturing industry. A mid-year survey (MR-61-21) is available from the Business and Defense Services Administration, Communications Industries Division, Washington 25, D. C. ✓✓✓ Information on a September 15, 1961 Government-Industry meeting on dust-free white room facilities is available from A. Lieberman, Armour Research Foundation, 10 West 35th St., Chicago 16, Ill.
- The Office of Naval Research, Washington 25, D. C. says it is considering a contract with Sweedlow, Inc., Los Angeles, Calif. on proposed fabrication of filament wound test chambers. ✓✓✓ Details on how a common detergent known as STP is speeding petroleum recovery in certain oilfields are available in Report of Investigations No. 5752, free from the Publications-Distribution Section, U. S. Bureau of Mines, 4800 Forbes Avenue, Pittsburgh 13, Pa. ✓✓✓ Thoughts by Ira H. Abbott, Director of Advanced Research Programs on "The Creation of a Good Research Environment" are available in Release 61-187 from Information Office, National Aeronautics and Space Administration, Washington 25, D. C. ✓✓✓ New regulations designed to end certain abuses by government-aided small business investment companies are available from the Small Business Administration, Office of Investment, Washington 25, D. C. ✓✓✓ The Martin Company is proposing development of an Army anti-tank missile using ultraviolet guidance techniques. ✓✓✓ A survey of "Instrumentation in Japan" is available at 10 cents from U. S. Department of Commerce Field Offices or the Publications Office, BDSA, Department of Commerce, Washington 25, D.C.



\* CHEMICAL CORPS SEEKS "BLUE SKY" IDEAS

The Army Chemical Corps is continuing to stress its "Blue Sky" program aimed at the generation of new ideas for chemical, biological and radiological (CBR) military technology.

Typical problems include:

- ✓ How can a soldier effectively carry out his mission in a CBR environment?
- ✓ How can this be done without impairing a soldier's ability to fight?
- ✓ How do you take an enemy's gun away without killing him?
- ✓ How can you quickly and accurately detect substances that are odorless, colorless and tasteless?
- ✓ How can this be done on a large scale, fast?
- ✓ How can you give complete protection against all forms of CBR attack?

(Anyone with ideas on these and related subjects is invited to contact the Blue Sky Committee, U. S. Army Chemical Corps, The Army Chemical Center, Md.)

\* NEW ORLEANS SITE FOR SPACE BOOSTERS

The National Aeronautics and Space Administration hopes to have in operation within a year the government-owned Michoud Ordnance Plant near New Orleans, La. for fabrication of large launch vehicle stages. The plant was originally designed to build ocean-going ships, but was altered in 1943 for construction of plywood airplanes, and in 1951 for production of tank engines. The plant was placed on a stand-by basis in 1954.

NASA will select a contractor who will eventually employ several thousand persons for fabrication and assembly of the first stage (S-1) of the Saturn launching vehicle, and larger boosters requiring at least two 1.5 million-pound thrust F-1 engines. The first ten Saturn boosters will be constructed at Huntsville, Ala. The plant will presumably be capable of fabricating stages of the larger Nova vehicle, although NASA officials have made no commitment on this point.

\* DOPPLER RADAR NAVIGATION

Federal Aviation Agency Administrator N. E. Halaby approves "in principle" aircraft cockpit navigation on North Atlantic air routes using Doppler radar -- with other cockpit navigational aids. Final approval depends upon a satisfactory completion of a pilot training program and "a refinement of procedures."

The preliminary approval was based on six weeks of flight evaluation by Trans World Airlines and FAA. The Doppler radar device provides a pilot with a precise track over the ground or sea, and precise ground speed. A pilot can select a course and a needle in the instrument before him indicates whether he is on course, or how many miles on either side. The instrument also indicates the distance from a given-point on a pre-selected course.

The system is of particular value when an aircraft is some distance from coastlines or navigational aids. However, other navigational aids in the cockpit are used to verify the Doppler radar track. These include VOR radio ranges near the coast; radar, for indications of shorelines or stationary navigation ships at sea; long range radio and Loran Long Range Navigation systems.

\* METEOROLOGICAL SATELLITE PROGRAMS

The most complete collection of publicly available material on U. S. weather satellite programs and policies, including detailed operational requirements for the forthcoming Nimbus satellite program, has now been published.

(Single free copies of "Hearings -- National Meteorological Satellite Program", 468 Pages, can be obtained from the Committee on Science and Astronautics, New House Office Bldg., Washington 25, D. C.)

## R E S E A R C H   C H E C K L I S T

- ACCELEROMETER SHOCK CALIBRATOR: The Sandia Corp. operating for the Atomic Energy Commission, has found that a special pendulum device, using a force transducer, can serve as an accurate shock calibrator for accelerometers. Investigators believe that by directly determining the accelerating force they can avoid the errors which are said to be found in other calibration techniques.
- (Details reported in Report SCTM 96-61(73) available through AEC channels or at 50 cents from OTS, U. S. Department of Commerce, Washington 25, D. C.)
- CALIBRATING LOOP ANTENNAS: The National Bureau of Standards has developed a technique for the precise and accurate determination of field strength of signals received from VLF (very low frequency) antennas. The technique can also be used at higher frequencies for calibrating loop antennas, generators, and voltmeters, and for determining effective heights of antennas or similar applications. The calibrating equipment is battery operated. Field strength is determined in terms of a quasi-static magnetic field with the two loop antennas positioned coaxially at a spacing of approximately two meters -- a considerable reduction when compared to conventional calibrating methods.
- (Details are available in Reprint Paper 65C3-70 from Office of Technical Information, National Bureau of Standards, Washington 25, D. C.)
- DETERMINING METALLIC TIN IN PROPELLANTS: The Army appears to have developed an improved method of determining the amount of metallic tin, and probably other metals, in various propellants. Metallic tin is frequently added to propellants to act as a flash reducer, but there has been no convenient means of testing for its presence. The proposed method is based upon colorimetric determination with the use of hematoxylin.
- (Frankford Arsenal Test Report T61-81-1 (AD 255 318) available through military channels or at \$2.60 from OTS, U. S. Department of Commerce, Washington 25, D. C.)
- PORTABLE GAS LEAK DETECTOR: The Navy has developed a portable gas leak detector used for safety checks aboard submarines and also expected to have wide commercial utility. The system can detect leaks in pressurized systems containing any gas which has a thermal conductivity different from that of air. The thermistor-bridge device is said to be simple, reliable and portable, while possessing excellent sensitivity.
- (Development report by A. Hafner, Radar Division, Equipment Research Branch, U. S. Naval Research Laboratory, Washington 25, D. C.)
- CENTRIFUGAL CASTING: The Argonne National Laboratory, operating for the Atomic Energy Commission, has successfully produced multiple castings of small diameter fuel pins with the aid of a centrifugal casting machine. Some 16 different metals and alloys were used as mold materials in these experiments. Investigators also attempted to cast centrifugally thin uranium plates. These efforts are said to be only partially successful, but encouraging.
- (Details reported in Report ANL 6177 available through AEC channels or at 50 cents from OTS, U. S. Department of Commerce, Washington 25, D. C.)

## P U B L I C A T I O N   C H E C K L I S T

- LECTURE ROOMS AND LABORATORIES, a listing of articles and papers relating to the design and construction of lecture rooms and laboratories in the fields of physics, chemistry and the natural sciences. Single Copies Free. (Write Specialized Information Section, EPA-OEEC, 3 rue Andre Pascal, Paris XVI, France for Question and Answer Summary QR 1950).
- EXPERIMENTAL BLAST FURNACE, a technical review of the significance of various experimental operations to industrial blast-furnace practice. 8 Pages. Single Copies Free. (Write Publication-Distribution Section, U. S. Bureau of Mines, 4800 Forbes Avenue, Pittsburgh 13, Pa. for Report of Investigation No. 5766)
- MODERN COMPUTING METHODS, a new edition of a popular work from Britain's National Physical Laboratory. Can be used as a working manual or as a basis for courses in numerical analysis. 176 Pages. \$3.80. (Write British Information Service, 45 Rockefeller Plaza, New York 20, N. Y. for Notes on Applied Science, No. 16)
- COLUMBIUM AND TANTALUM, a review of major developments in the technology and alloys of columbium and tantalum for the period April-June, 1961. 4 Pages. (Single Copies Free to Government agencies, their contractors, subcontractors and suppliers. (Write Defense Metals Information Center, Battelle Memorial Institute, Columbus 1, Ohio for DMIC Memorandum No. 115)
- EQUATORIAL LAUNCH SITES, a report on the need for space launching sites at the Equator, and the capabilities of the Navy for mobile sea-launching. 10 Pages. Single Copies Free. (Write Committee on Science and Astronautics, New House Office Building, Washington 25, D. C. for House Report No. 710)
- ATMOSPHERIC DENSITY, a technical study of the variability of atmospheric density from the surface of the earth to re-entry altitude, of importance in such programs as Project Apollo. 24 Pages. Single Copies Free. (Write National Aeronautics and Space Administration, 1520 H Street, N. W., Washington 25, D. C., ATTN: CODE BID for NASA Technical Note D-612)
- EDUCATIONAL AND TRAINING MEDIA, the proceedings of an Air Force-sponsored 1959 symposium dealing with such subjects as films, television, part trainers and teaching machines. 206 Pages. \$2. (Write Printing and Publishing Office, National Academy of Sciences, 2101 Constitution Avenue, N. W., Washington 25, D. C. for Publication No. 789)
- THE ROMOTAR SYSTEM, a technical report on the "Range Only Measurement of Trajectory, Automatic Recording" system installed at the test range which the Sandia Corp. operates at Salton Sea, California. 21 Pages. (Report SCTM-1-61(72) available through AEC channels or at 75 cents from OTS, U. S. Department of Commerce, Washington 25, D. C.)
- CALCULATION AND USE OF ION ACTIVITY, a discussion of the processes by which natural water acquires or relinquishes solutes, in relation to ionic activity. 17 Pages. 50 Cents. (Write Superintendent of Documents, Government Printing Office, Washington 25, D. C. for Publication No. I 19.13:1535-C)
- BIBLIOGRAPHY OF TEMPERATURE MEASUREMENT, a listing of more than 500 references covering the period 1953-June, 1960. 13 Pages. 15 cents. (Write Superintendent of Documents, Government Printing Office, Washington 25, D. C. for Publication No. C 13.44:27)

